

# Water Pollution Status of Mula-Mutha Rivers in Pune City: Review

Shruti Subhash Jagtap<sup>1, 2</sup>, Dr. R Manivanan<sup>2</sup>

<sup>1</sup>Department of Civil Engineering, Sinhgad Institute of Technology & Science, Pune, Maharashtra, India

Scientist 'B', <sup>2</sup>Central Water & Power Research Station, Pune, Maharashtra, India

## ABSTRACT

Mula-Mutha rivers in Pune (Maharashtra, India) are in highly insanitary and unhealthy conditions. It flows along a 22-km stretch through Pune city and is Maharashtra's second most polluted river of 2018, containing human and animal excreta three times more than the safe limit, according to Maharashtra Pollution Control Board (MPCB). Despite riverfront development for Mula-Mutha rivers by Pune Municipal Corporation (PMC), domestic waste, untreated sewage and industrial effluents is dumped into the river. Waste is the potentially dangerous byproduct of a wide range of activities, including manufacturing, farming, water treatment systems, construction, automotive garages, laboratories, hospitals, and other industries. The waste may be liquid, solid, or sludge and contain chemicals, heavy metals, radiation, pathogens, or other materials (source: website 1). The objective of this review work is to analyze the degree of pollution in a decade or more. This review study gives information of five parameters namely pH, DO, BOD, COD, hardness at three study locations for the years 2006, 2008, and 2017 respectively. The trend of water pollution is also depicted from tabular data and graphs, where the status of contaminated river water is discussed. Remedial measures are suggested to mitigate high pollution levels in river.

**KEYWORDS:** insanitary; degree of pollution; pH; DO; BOD; COD; Hardness; water pollution; contaminated; remedial measures

## INTRODUCTION

Rapid growth of industrialization, urbanization and globalization has greatly affected the rivers flowing through Pune city. River plays an important role in economic growth and is an asset of this city. Rivers are one of the humankind's most valuable resources. Millions of the people all over the world live on the banks of rivers and depend on them for their survival. Rivers have provided water for populations and industries as a navigation route for materials and commerce (Neal *et al* 2006). The Mula-Mutha River is a river in western Maharashtra. It arises in the Western Ghats and flows eastward until it merges with the Mula River in the city of Pune. The Mula-Mutha is a river in Pune, formed by the confluence of the Mula and Mutha rivers in the city of Pune, which later meets the Bhima River, which itself later meets the Krishna River and finally emptying into the Bay of Bengal (EIA report, PMC). Mula-Mutha River starts its journey from Sahyadri ranges and finally drains into the Bay of Bengal. It is lifeline of Pune which is in dire straits. This river has become dangerous and highly polluted due to direct discharge of sewage, industrial effluents, intensive farming and overuse of fertilizers in agricultural production and various anthropogenic activities resulting a great threat to public, water body creatures who live and feed around the river. It also affects the ground water quality. Mutha river has been dammed twice, firstly at the Panshet dam, used as a

source of drinking water for Pune city and irrigation. The water released here is dammed again at Khadakwasla and is important source of drinking water for Pune. One more dam has been built later on the Mutha River at Temghar (Wagh *et al*). The studies are essential on river water quality to evaluate various parameters which affects the quality during its course through the city. Pune city was originally a small settlement on the banks of the river. Historic embankment walls still seen today suggest that Pune city was a small settlement on higher land on the banks of the river. However, over the time, the city has spread exponentially. Today the development surrounds the river and at some places is also seen within the riverbed (EIA report, PMC). The present paper is proposed to review the water pollution status over a decade or more.

## STUDY LOCATION

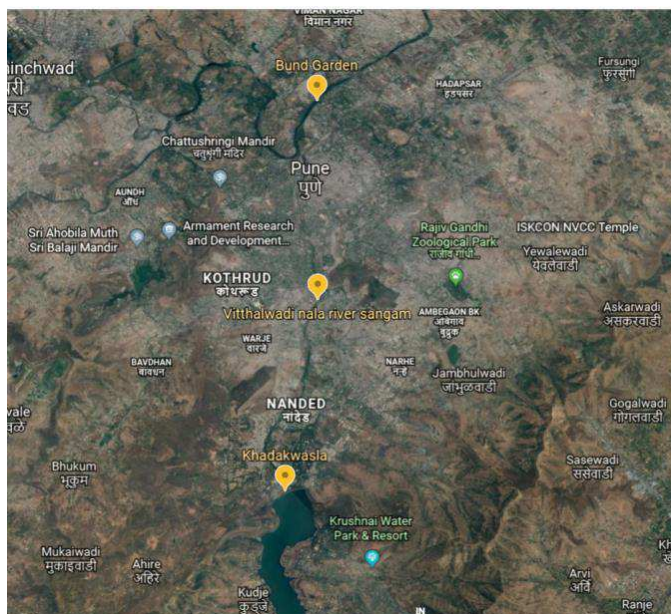
To analyze the water quality of Mula-Mutha river, various study locations were taken namely Khadakwasla dam, Vitthalwadi, Bund garden, Rajaram bridge, Mhatre bridge, Holkar bridge, etc., out of which only 3 study locations are used in this paper for analysis and comparison purpose. Figure 1 given below depicts the location of the sampling stations from where the water samples were collected.

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**Fig1: Figure showing 3 study locations**  
(source: website 2)

The 3 study locations are as follows:

#### A. Khadakwasla



**Fig2: As the river flows further downwards and approaches the Khadakwasla dam, the polluted water can be seen. (Source: website 3)**

#### B. Vitthalwadi



**Fig3: The river undergoes change as it approaches and flows through the Vitthalwadi ghats before entering the city. The ghats look neglected, the river has very less water and the garbage floating over the waters presents a revolting sight. Channelization has choked the river, killing its springs and streams. (source: website 3)**

#### C. Bund garden



**Fig4: Figure showing polluted river water at bund garden bandhara (source: website 4)**

#### METHODOLOGY

Firstly, theoretical background of Mula-Mutha river was thoroughly studied. The study locations were selected. Then the water sample of Mula-Mutha rivers were collected in clean plastic bottles during summer season. The bottles were labelled and corked tightly. To assess the level of pollution of river, the above water samples collected were analyzed for various parameters like pH, DO, BOD, COD, hardness. The analysis of water samples was done using American Public Health Association (APHA) standard procedure.

The procedure for 5 parameters is as follows:

1. pH was measured using digital pH meter (Systronics make) in the laboratory. The pH meter was calibrated for 4.0 and 9.2 buffer solution.
2. Biochemical oxygen demand (BOD) was calculated as the difference between initial oxygen concentration and after incubating it for 5 days at 20°C i.e. final oxygen concentration.
3. Chemical oxygen demand (COD) was determined by titrating the samples 0.1N ferrous ammonium sulphate using ferroin indicator.
4. The amount of dissolved oxygen (DO) was determined by using Winkler's iodometric method.
5. Total hardness was determined by titrating the sample with EDTA solution using Erichrome Black T as indicator.

This methodology is adopted by various authors like Neal *et al* (2006), Wagh *et al* (2008), Jadhav *et al* (2017), etc. After following the above procedures, the comparison of various years pollution level with respect to 5 parameters is provided in the tabular data as well as graphical representation. Then the remedial measures are suggested.

#### RESULTS AND DISCUSSIONS

Mula-Mutha rivers are considered to be sewer lines (nala) more than river, for which analysis and mitigation measures is to be taken. So, assessment of water quality using physico-chemical parameters is carried out by various authors. Table-1 illustrates the comparative study for variation of parameters over decade 2006, 2008 and 2017 at three study areas. The information provided in table below is taken from three published papers and data of three years is taken in order to see the water pollution status.

The studies were carried out to assess and analyze these parameters during the summer season.



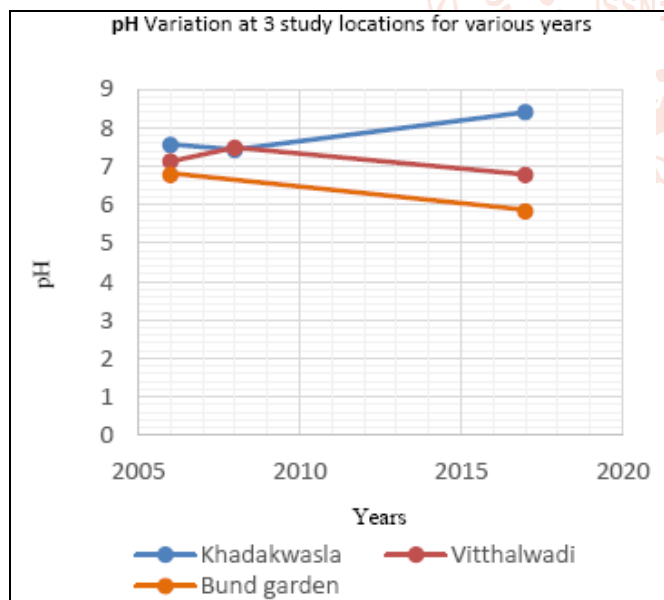
**TABLE1: WATER POLLUTION AT 3 STUDY LOCATIONS BELOW**

Study Location	Years	2006	2008	2017
Khadakwasla	pH	7.56	7.43	8.4
	DO	-	6.43	2.3
	BOD	42.0	21.5	9.51
	COD	-	58	44
	Hardness	40	43	33.12
Vitthalwadi	pH	7.12	7.48	6.78
	DO	-	0.35	0.8
	BOD	80.7	125.5	31
	COD	-	394.25	87
	Hardness	136	151.25	88.91
Bund garden	pH	6.77	-	5.83
	DO	-	-	0.6
	BOD	26.8	-	63
	COD	-	-	287
	Hardness	122.7	-	304

The given line graphs are deduced from the above table and the trend of water pollution during years 2006, 2008 and 2017 is shown.

#### ➤ pH variation

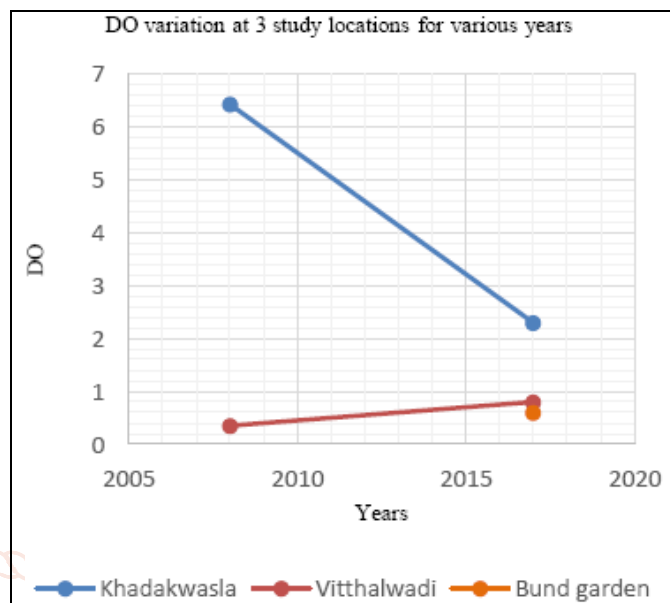
From the figure 5, we can see that maximum pH is at Khadakwasla during 2017 which indicates that water is becoming more alkaline as various activities like washing clothes, cleaning animals is carried out by population residing in Khadakwasla or nearby village. The value for pH at Vitthalwadi seems to be increasing first and then decreasing which means water is becoming acidic. The photosynthesis of aquatic plants in Vitthalwadi region reduced due to garbage mainly plastic floating over the river water.

**Fig5: pH variation at 3 study locations for various years**

#### ➤ DO Variation

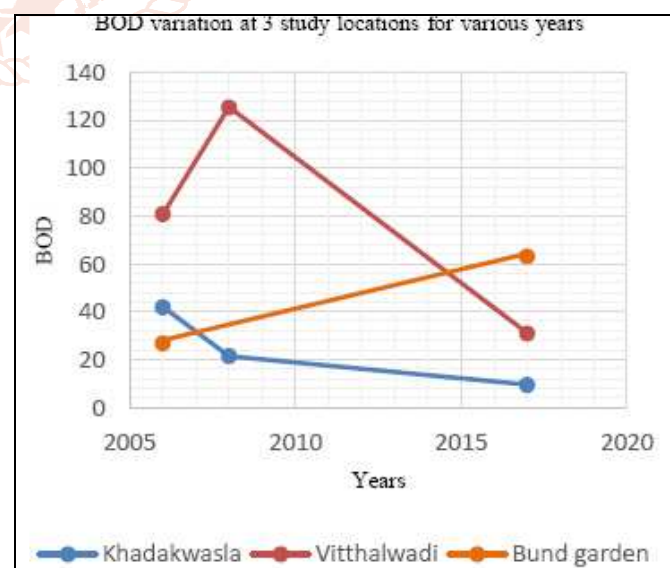
DO is one of the important parameters of Water quality. The maximum value of DO is 6.43 mg/l during 2008 at Khadakwasla and the above line graphs shows that the value is decreasing at a sudden rate and after 9 years the value drops to 2.3 mg/l, which is of a great concern indicating water is highly polluted. This variation may be due to

excessive algae growth caused by phosphorus and decomposition of submerged plants also contributes to low dissolved oxygen. At Vitthalwadi we can see that value of DO is improved from 0.35 mg/l in 2008 to 0.8 in 2017 as a result from above figure 6.

**Fig6: DO variation at 3 study locations for various years**

#### ➤ BOD Variation

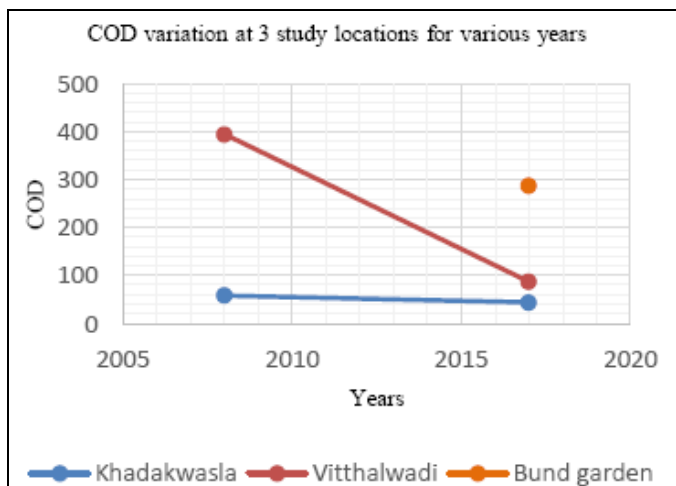
The amount of Oxygen required to degrade biologically active organic matter in presence of bacteria through biodegradation is called BOD which is estimated under specific conditions of temperature (20°C) and time duration (5 days). At Vitthalwadi the value of BOD is first increasing from 80.7 mg/l to 125.5 mg/l (maximum value) the decreasing pattern is observed from figure 7. At Khadakwasla the values are decreasing from 42 mg/l in 2006 to 9.51 mg/l in 2017. Lower BOD indicates less pollution in water.

**Fig7: BOD variation at 3 study locations for various years**

#### ➤ COD Variation

The amount of oxygen required to degrade both biologically active and biologically inactive organic impurities in sewage either by biodegradation or by chemical degradation using

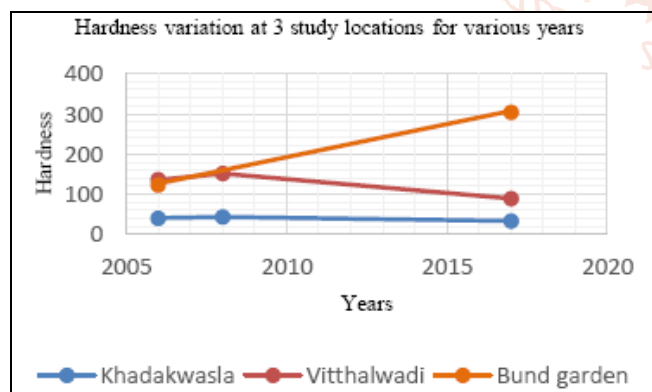
either bacteria or chemicals is called COD. At first, COD value of 394.25 mg/l is maximum during 2008 at Vitthalwadi and then rapid decrease in COD value can be seen up to 87 mg/l. Slight decrease is seen at Khadakwasla station from 58 mg/l to 44 mg/l. The lower value for COD reveals that water quality is improving after a decade or more from 2006 to 2017 which is evident from above figure 8.



**Fig8: COD variation at 3 study locations for various years**

#### ➤ Hardness Variation

The inability of water for lather formation due to presence of Calcium and Magnesium salts is called hardness. Its value for Khadakwasla is 40 mg/l of  $\text{CaCO}_3$ , 43 mg/l of  $\text{CaCO}_3$ , 33.12 mg/l of  $\text{CaCO}_3$  during 2006, 2008 and 2017 respectively which indicates a slight increase at first then decrease. From figure 9, we can see a tremendous increase in value for hardness from 122.7 mg/l of  $\text{CaCO}_3$  (2006) to 304 mg/l of  $\text{CaCO}_3$  (2017), which is of great concern at Bund Garden site. At Vitthalwadi values are 136 mg/l of  $\text{CaCO}_3$ , 151.25 mg/l of  $\text{CaCO}_3$ , and 88.91 mg/l of  $\text{CaCO}_3$  during 2006, 2008 and 2017. This indicates slight increase from 2006 to 2008 and then rapid decreasing to nearly half of its value in 2017.



**Fig9: Hardness variation at 3 study locations for various years**

#### CONCLUSION

The trend is of decreasing pH levels at Vitthalwadi and Bund garden, making the river water acidic. Increase in pH is only observed at Khadakwasla making water alkaline. The trend of BOD and COD is of decreasing level which means control of water pollution to an extent is observed at Khadakwasla and Vitthalwadi. This is possible because of initiative taken by Pune Municipal Corporation (PMC) by increasing number of Sewage Treatment Plants (STP) and introducing laws, etc.

The levels of BOD and COD are increasing at Bund garden. This is because of the both natural and human factors one being decomposition of algae that contain a lot of organic matter. The trend shows a huge reduction in DO at one of the study locations, namely Khadakwasla, which indicates heavy contamination by organic loading. As DO drops below 4 it indicates poor water quality and no aquatic life. Hardness is decreasing at Khadakwasla and Vitthalwadi and is increasing at Bund Garden.

A common trend of river water getting polluted is seen at Bund garden location in case of BOD, COD and Hardness. A low value of DO is also observed at Bund garden. This clearly indicates that out of all the three study areas, Bund garden has highly contaminated river water as it is one of the busiest areas in the Pune city. The combination of domestic waste, agricultural run-off and industrial effluents are making river water vulnerable. The local residents have turned the river as a dumping site for various domestic wastes such as pooja material, plastics etc.

#### REMEDIAL MEASURES

Various mitigation steps have been proposed to control water pollution:

- Construction of a greater number of STPs, laying of 113.6 km of sewer lines for collection of untapped sewage and rehabilitation of four existing intermediate pumping stations (source: website 5).
- Bioremediation is one of economic and feasible method to control river pollution aerobically. Bioremediation is the use of living organisms, primarily microorganisms, to degrade the environmental contaminants into less toxic forms. It uses naturally occurring bacteria and fungi or plants to degrade or detoxify substances hazardous to human health and/or the environment (Anaokar *et al*, 2013).
- Self-purification of river is naturally occurring process which consists of actions like dilution, oxidation, reduction, sedimentation, temperature, current and action of sunlight.
- Phytoremediation is a bioremediation process that uses various types of plants to remove, transfer, stabilize or destroy contaminants in the soil and groundwater. In this Phytoid technology treatment, is used for the removal of fecal coli forms, BOD, COD. Nutrients are up to 95%, which is greater than the traditional chemical methods. It is a cost-effective technology as compared to the traditional wastewater treatment methods. Since it utilizes natural vegetation and rhizosphere microorganisms, it is an eco-friendly method of treating sewage. The polluted water is allowed to pass through the root zones of the Phytoid beds (source: website 6).
- Membrane Aerated Biofilm Reactor (MABR) is a unique attached growth biofilm (fixed film) aeration system that greatly increases energy efficiency and capacity of wastewater treatment plants (WWTPs). In WWTPs, aeration is used to deliver oxygen to bacteria that breakdown pollutants in wastewater. The conventional method of adding oxygen by pumping air and diffusing it as air bubbles is very energy-intensive. Instead, MABR uses a gas permeable membrane to transfer oxygen directly to the microorganisms. Through this system, energy savings of 75% are observed. MABR can be

deployed in a matter of days to supplement the biological treatment capacity of an existing Activated Sludge process. After implementation, a plant can increase its treatment capacity by 50%, allowing for either higher treatment capacity or higher effluent quality. So wherever necessary it can be installed for treatment of polluted water (source: website 7).

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